NUCLEAR ENERGY RESEARCH INITIATIVE

Uncertainty Quantification in the Reliability and Risk Assessment of Generation IV Reactors

PI: Karen Vierow, Purdue University

Collaborators: The Ohio State University

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Program Area: Generation IV

Project Description

The goal of this project is to develop practical approaches and tools for dynamic reliability and risk assessment techniques, which can be used to augment the uncertainty quantification process in probabilistic risk assessment (PRA) methods for Generation IV reactors. The objectives of the project are to develop practical approaches and computationally efficient software packages designed to test event tree completeness for Generation IV reactors, integrate a reactor safety code with PRA, and assess and propagate plant state uncertainties in the PRA analysis.

This project involves generating a dynamic event tree and propagation and quantification of uncertainties. Current software for Dynamic Event Tree generation will be modified and linked to a best-estimate computer code (MELCOR for demonstration purposes). Key uncertainties in Generation IV modeling will be identified via the Phenomena Identification and Ranking Table technique. The integrated software package will be tested on selected, high-risk initiating events. In Phase 2, the computational efficiency will be improved by coupling the Dynamic Event Tree generation software with sampling software developed by Sandia National Laboratories. A purely numerical version of Devooght's and Dessar's uncertainty propagation methodology will be developed from a semi-analytical form and incorporated into the coupled best-estimate code/dynamic event tree generator package. Finally, the new software will be tested for selected initiating events.

Workscope

The following key activities/tasks will be performed:

- Dynamic event tree generation
  - Develop the SCHEDULER, PROBABILITY MODULE, and DATABASE MANAGEMENT SYSTEM and link to the MELCOR code
  - Determine key uncertainties in reactor modeling and high-risk initiating events
  - Test the software on selected initiating events
- Uncertainty propagation and quantification
  - Link the coupled MELCOR/DET generation scheme to the SNL Monte Carlo/Latin Hypercube Sampling tool
  - Test for selected initiating events for the Pebble Bed Modular Reactor (PBMR)

- Modify the Devooght and Dessars methodology from semi-analytical to a purely numerical algorithm and incorporate into the PROBABILITY MODULE of the coupled MELCOR/DET generation scheme
- Test the new software for initiating events